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World Journal of Biological Research
Revue Mondiale de la Recherche Biologique

World Journal of Biological Research 003: 1

Published: 15 FEBRUARY 2010

Toxic Effects of Aqueous and Ethanol Extracts of *Parkia biglobosa* Pods on *Clarias gariepinus* Adults.

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Abstract:

The toxic effects of aqueous and ethanol extracts of *Parkia biglobosa* pods (85mg/L, 100mg/L, 115mg/L, 130mg/L and 145mg/L) on adult *Clarias gariepinus* was investigated under laboratory conditions. Signs of agitated behaviours, respiratory distress and abnormal nervous behaviours including eventual deaths were observed in exposed fish. Control fish neither died nor exhibited any unusual clinical signs. Both extracts are of low toxicity having a 48 h and 96 h LC₅₀ values of 109.42mg/L and 105.83mg/L for the aqueous extract and 151.36mg/l and 135.64mg/L for the ethanol extract respectively. Safe concentration of 10.58mg/L and 13.56mg/L were established for aqueous and ethanol extracts of *P. biglobosa* pods. It shows that outside the bark of *P. biglobosa*, the pods of the same plant equally have piscicidal property.

Key words: *Parkia biglobosa* pods, *Clarias gariepinus*, toxicity, clinical signs, lethal concentrations, safe concentrations.

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INTRODUCTION

Fish farming or aquaculture is reported to be the fastest growing food production system world wide (Francis, Makkar & Becker, 2001). This is because fishes have high feed conversion ratio coupled with their high utilization of both agricultural and animal wastes leading to high productivity and high returns while providing the much needed employment opportunities (Katina, 2000). However, aquaculture production is greatly influenced by the presence of pests, predators and competitors of cultivated fishes (Chiavareesajja & Chiavareesajja, 1997). These unwanted fishes may be introduced into aquaculture through water supplies or along with desired fishes at stocking (Cagauan, Galaites & Fajardo, 2004) and their control is therefore, a vital aspect of pond management for enhanced productivity (Jothivel and Paul, 2008).

Complete pond drainage alone or along with sun drying for cracked pond bottoms are often undertaken to control or eradicate these unwanted fishes including the use of screening as a standard method of preventing their entry into ponds but these measures are usually inadequate (Bardach, Ryther & McLarney, 1972; Jhingran, 1983; Cagauan *et al.*, 2004). These have led to the rampant use of synthetic compounds by farmers but for their undesirable toxic consequences on man and the environment (Terry, 1987; Fafioye and Jeje, 2000). However, plants that are poisonous to fishes (plant piscicides) are now seen as effective alternatives to these toxic synthetic compounds (Dahiya, Kaur & Jain, 2000) because they are bio-degradable (Kela, Ogunsusi, Ogbogu & Nwude, 1989) and are less severe to man and the environment than synthetic compounds (Ahmed and Grainge, 1986). The toxicity of piscicidal plants to fishes have been reported (Chiavareesajja *et al.*, 1997; Usman, Auta, Adamu & Abubakar, 2005;

Akinbulumo, Fagbenro & Fasakin, 2008) including the toxic effect of extracts of *Parkia biglobosa* bark on *Clarias Gariepinus* juveniles (Fafioye, Adebisi & Fagade, 2004). However, there is a need to determine if other parts of this highly valuable *P. biglobosa* plant (Dalziel, 1955; Irvine, 1962; Obiozoba, 1998; Ajaiyeoba, 2002; Agunu, Yusuf, Andrew & Abdulrahman, 2005; El-Mahmood and Ameh, 2007) have piscicidal properties outside the bark hence this study which is aimed at investigating the toxic effects of aqueous and ethanol extracts of *P. biglobosa* pods on *C. gariepinus* adults, a fish that abound freely in Nigerian freshwaters (Fagbenro, 1992).

MATERIALS AND METHOD

Plant collection, preparation and extraction

Parkia biglobosa pods were collected and sun dried before blending them into fine powder prior to extraction. Six liters of distilled water was used to soak 1000.00g of the fine powder of *P. biglobosa* pods over night prior to filtration based on maceration method (Bentley, 1977; Ghani, 1990) which was subsequently freeze dried yielding 429.00g (45.90%w/w) of the freeze-dried aqueous extract. Five liters of ethanol absolute was also used to soak 1260.00g of the fine powder of *P. biglobosa* pods over a 48 hour (h) period prior to filtration based on the same maceration method (Bentley, 1977; Ghani, 1990) which was subsequently concentrated to dryness over a 72 h period yielding 725g (57.56%w/w) of dry ethanol extract.

Fish collection and preparation

Clarias gariepinus adults of 163.70 ± 3.71 g mean weights and 27.23 ± 0.19 cm mean total lengths were purchased from a commercial farm in Katsina, Katsina State, Nigeria and acclimatized in the laboratory for 14 days. They were fed *ad libitum* daily with commercial catfish feed (Multi feed, Zelmach feed mill, Israel) while pond water was changed every other day. Total acclimatization mortality was less than 5% and feeding was stopped 48 h prior to and during the entire 96 h experimental period (Adeyemo, 2005) in order to minimize interference by the stomach contents and wastes from exposed fish (Ayotunde and Ofem, 2008; Olufayo, 2009).

Toxicity testing

A static bioassay was done (APHA/AWWA/WPCF., 1985) after performing a

range finding test to obtain five graded concentrations (Usman *et al.*, 2005) of 85mg/L, 100mg/L, 115mg/L, 130mg/L and 145mg/L for both extracts of *P. biglobosa* pods on *C. gariepinus* adults with controls containing no extracts. Ten fish were randomly introduced into each of the reconstituted extracts after allowing them to stand for 30 minutes to ensure their proper mixing. Clinical signs and deaths were closely monitored and recorded at the onset, 3 h, 6 h, 12 h, 24 h, 48 h, 72 h and 96 h respectively. Lethal concentrations (LC₅₀)

The lethal concentrations (LC₅₀) for 48 h and 96 h were determined by subjecting results to Probit and logit analyses (Finney, 1971).

Safe concentrations

Safe concentrations of both extracts were calculated by multiplying their respective 96 h LC₅₀ by an applicator factor of 0.1 (EIFAC, 1983).

Level of toxicity

The level of toxicity for both extract was determined based on Czechoslovak division standard, ON 466807 acute toxicity test on fish and other aquatic organisms using 48 h LC₅₀ (Svobodová, Llyod, Machová & Vykusová, 1993).

Statistical analysis

Microsoft Office Excel (2000) was used to plot the probit and logit analyses (Finney, 1971) in order to establish the 48 h and 96 h LC₅₀ respectively.

RESULTS

The clinical manifestations of the toxic effects of aqueous and ethanol extracts of *P. biglobosa* pods on *C. gariepinus* adults were as in Table 1 – 3. Exhibited agitated behaviours increased with increasing extracts concentrations but decreased with exposure period for both extracts except for raised fins which lasted through out the 96 h exposure period. The intensity of respiratory distress increased with increasing extracts concentrations but decreased with exposure period for both extracts except for the excessive mucus secretions and vertical positioning with exposed snouts where intensity increased with exposure period for both extracts. The observed abnormal nervous behaviours increased with increasing extracts and exposure period for both

Table 1: Agitated behaviours

Clinical signs	Exp. Group	Extracts concentrations (mg/L)					
		0	85	100	115	130	145
Aggression	A	-	-	-	-	++	+++
	B	-	-	-	+	++	+++
Jumping	A	-	-	+	++	+++	+++
	B	-	-	+	++	+++	+++
Raised dorsal fins	A	-	-	++	++	+++	+++
	B	-	-	++	++	+++	+++
FSBM	A	-	-	-	+	++	+++
	B	-	-	+	+	++	+++

Legend: Experimental group (Exp. group), Frequent surface to bottom movements (FSBM), aqueous extract (A), ethanol extract (B), none (-), weak (+), moderate (++) and strong (+++).

Table 2: Respiratory distress

Clinical signs	Exp. Group	Extracts concentrations (mg/L)					
		0	85	100	115	130	145
Opercula movement	A	-	-	-	+	++	+++
	B	-	-	-	+	++	+++
Air gulping	A	-	-	-	-	+	++
	B	-	-	-	+	+	++
VPES	A	-	-	-	-	+	++
	B	-	-	-	+	+	++
EMS	A	-	+	++	++	+++	+++
	B	-	+	++	++	+++	+++

Legend: Experimental group (Exp. group), Vertical position with exposed snouts (VPES), Excessive mucus secretion (EMS), aqueous extract (A), ethanol extract (B), none (-), weak (+), moderate (++) and strong (+++).

Table 3: Abnormal nervous behaviours

Clinical signs	Exp. Group	Extracts concentrations (mg/L)					
		0	85	100	115	130	145
SSM	A	-	-	-	+	+	++
	B	-	-	-	+	+	++
State of motionless	A	-	+	++	++	+++	+++
	B	-	+	++	++	+++	+++
Sudden darts	A	-	-	-	-	+	++
	B	-	-	-	+	+	++
VAFP	A	-	+	++	++	+++	+++
	B	-	+	++	++	+++	+++
Rolling on their axis	A	-	-	-	-	-	+
	B	-	-	-	-	-	+
Loss of balance	A	-	-	-	-	-	+
	B	-	-	-	-	-	+
Death	A	-	+	++	++	+++	+++
	B	-	+	++	++	+++	+++

Legend: Experimental group (Exp. group), Sluggish and swirling movements (SSM), Vertical, angular or flat positions (VAFP), aqueous extract (A), ethanol extract (B), none (-), weak (+), moderate (++) and strong (+++).

Table 4: The LC₅₀ values of aqueous and ethanol extracts of *P. biglobosa* pods in *C. garipepinus* adults

Experimental exposure period	LC ₅₀ for aqueous extract	LC ₅₀ for ethanol extract
48 h	109.42mg/L	151.36mg/L
96 h	105.83mg/L	135.64mg/L

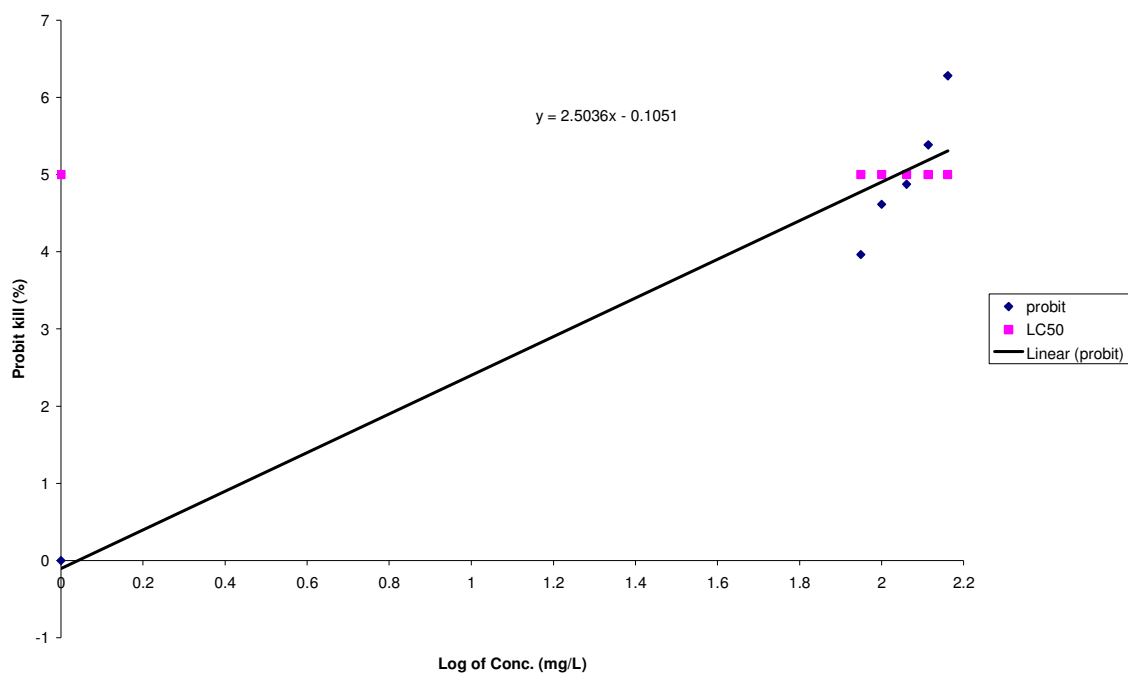


Fig. 1: Log of Concentrations of aqueous extracts of *P. biglobosa* pods and its probit value in exposed *C. garipepinus* adult (48 h).

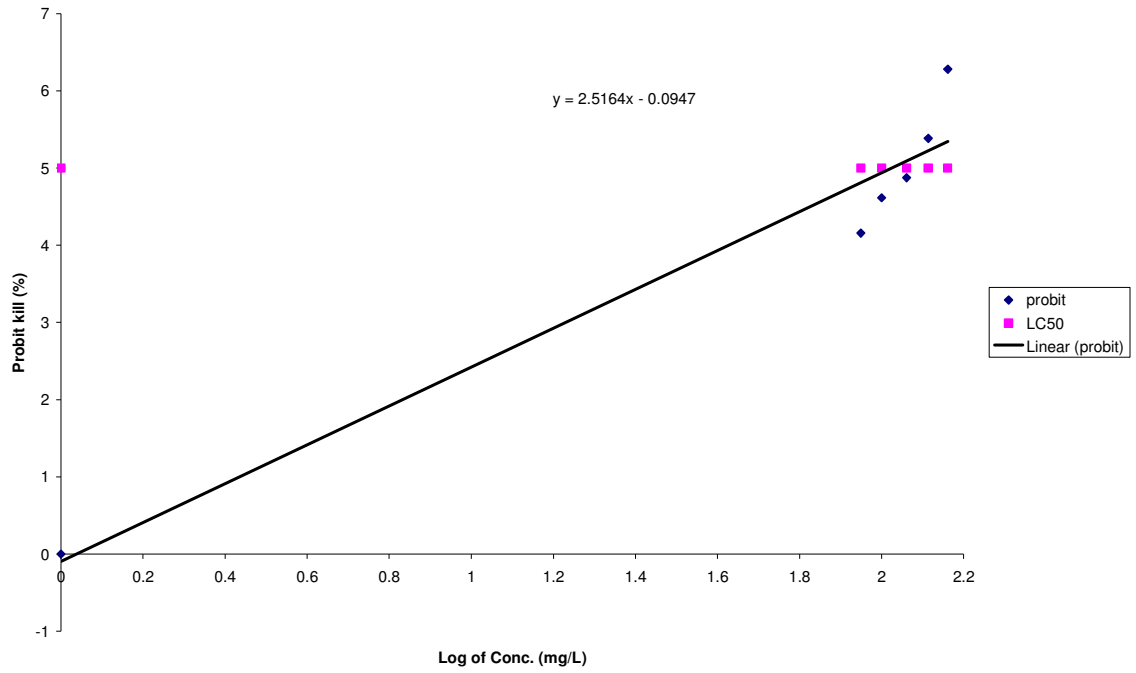


Fig. 2: Log of Concentrations of aqueous extracts of *P. biglobosa* pods and its probit value in exposed *C. garipepinus* adult (96 h).

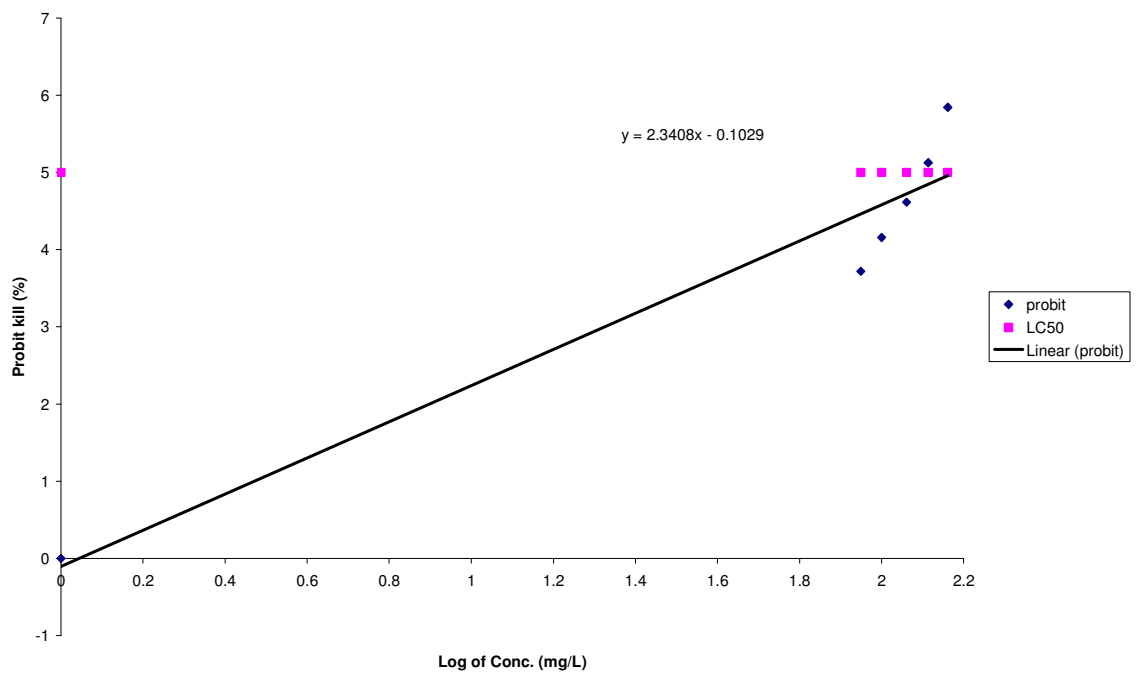


Fig. 3: Log of Concentrations of ethanol extracts of *P. biglobosa* pods and its probit value in exposed *C. garipepinus* adult (48 h).

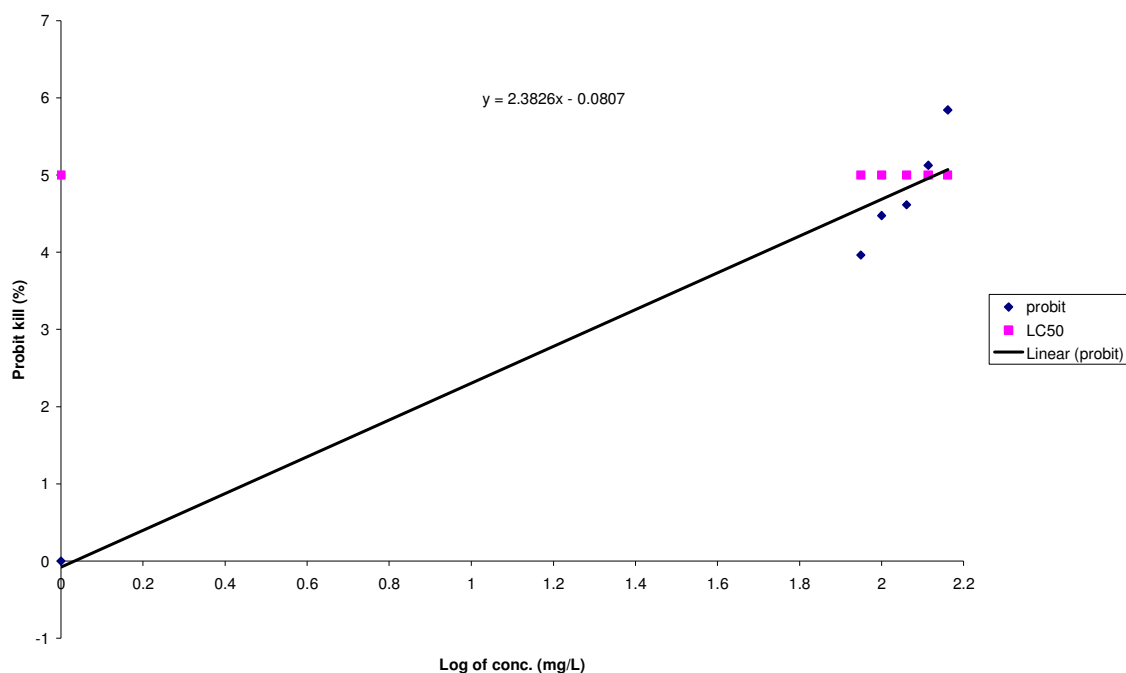


Fig. 4: Log of Concentrations of ethanol extracts of *P. biglobosa* pods and its probit value in exposed *C. gariepinus* adult (96 h).

extracts except for sudden darts which decreased with exposure period. Control fish exhibited no unusual signs nor died through out the 96 h exposure period. However, deaths were more in fish exposed to the aqueous extracts than in fish exposed to their ethanol extracts counterparts. The 48 h and 96 h LC₅₀ for both extracts (Table 4) were determined from Fig. 1-4 while safe concentrations of aqueous and ethanol extracts of *P. biglobosa* pods on *C. gariepinus* adults were 10.58mg/l and 13.56mg/L respectively.

DISCUSSION

The exhibited clinical signs and eventual deaths of exposed fish may be due to direct poisoning leading to pathological alterations in their tissues and organs (Gabriel, Ezeri & Amakiri, 2007; Mohammed, 2008) or may indirectly be due to changes in the physicochemical conditions of their immediate external environment (Ayoola, 2008a; Olufayo, 2009). The agitated behaviours correspond to both the contact and exertion phases of fish's response to toxicants exposures (Besch, 1975) and it is their natural response in trying to escape from absorbing these offending extracts. Our findings agree with the report of Adedeji, Adedeji, Adeyemo & Agbede (2008). The observed respiratory distress may be due to ensuing hypoxic states in exposed fish brought

about by both decreasing dissolved oxygen contents of reconstituted extracts vis-à-vis decreasing ability of exposed fish to respire. Decreasing dissolved oxygen content of reconstituted extracts may be due to the continuous oxidative bio-degradation of the constituents of both extracts which may cause oxygen tension in such reconstituted extracts by diverting the much needed dissolved oxygen for this bio-degradation process (Dede and Kaglo, 2001). However, the extent of such dissolved oxygen depletion is directly dependent upon the pollutant's concentrations (Horsefall and Spiff, 1998). Gills and skin pathological alterations have been reported in fishes exposed to toxicants (Lindesjö and Thulin, 1994; Das and Mukherjee, 2000; Soufy, Soliman, El-Manakhly & Gaafa, 2007) including their devastating effects on exposed fish's ability to respire (Obomanu, Ogbalu, Gabriel, Fakarurhobo & Abadi, 2007). The presence of excessive mucus secretions (Tiwari and Singh, 2005; Jothivel and Paul, 2008) as observed in this study could have increased this respiratory impairment by forming thin layers over the already compromised delicate and sensitive gill thereby hindering active gaseous exchange (Sambasiva Rao, 1999) and may therefore, be responsible for the exhibited respiratory distress and death (Omoniyi, Agbon & Sodunke, 2002). Our findings of respiratory distress agree with the report of Ayoola (2008b).

The abnormal nervous behaviours could be due to disruption of nervous system activity depending upon the part and extent of such nervous involvement. Our findings agree with the reports of Omoniye *et al.*, (2002) and Omitoyin, Ajani, Adeshina & Okuagu, (2006) while the observed increasing state of inactivity with both increasing extracts concentrations and exposure period agree with the report of Ayoola (2008a).

Our 96 h LC₅₀ values of 105.83mg/L and 135.64mg/L for both aqueous and ethanol extracts of *P. biglobosa* pods were much higher than 0.19mg/L and 4.2mg/L reported by Ayotunde, Fagbenro, Adebayo & Amoo (2008) and Wade, Omoregie & Ezenwaka (2002). This means that the aqueous and ethanol extracts of *P. biglobosa* pods were less toxic to *C. gariepinus* than the extracts of *Carica papaya* and *Manihot esculenta* that were used on *Oreochromis niloticus* adults respectively by both authors.

The aqueous and ethanol extracts of *P. biglobosa* pods are of low toxicity to exposed *C. gariepinus* adults based on the Czechoslovak division standard, ON 466807 acute toxicity test on fish and other aquatic organism (Svobodová *et al.*, 1993). The established safe concentrations of 10.58mg/L and 13.56mg/L for aqueous and ethanol extracts of *P. biglobosa* pods on *C. gariepinus* adults are the concentrations below which normal growth, reproduction and other life processes of exposed fish are expected to continue or flourish without any adverse effect.

CONCLUSION

The fact that aqueous and ethanol extracts of *P. biglobosa* pods caused some clinical behavioural changes and the ultimate deaths of exposed *C. gariepinus* adults shows that both extracts are toxic. This means that the extracts of *P. biglobosa* pods equally have piscicidal property like the extracts of the barks of the same plant on *C. gariepinus* and can therefore, be used to eradicate unwanted fishes from ponds prior to the stocking of desired fish species.

ACKNOWLEDGEMENT

Our sincere appreciations go to Mr. Stephen, S. W., Mr. Umar, A. and Mr. Ndaka, J. O. who provided immensurable assistance during the experimental set-up and also to the Department of Veterinary Anatomy, Ahmadu Bello University, Zaria, Nigeria for providing the experimental space.

REFERENCES

Adedeji, O.B., Adedeji, A.O., Adeyemo, O.K., Agbede, S.A, 2008. Acute toxicity of diazinon to the African catfish (*Clarias gariepinus*). African Journal of Biotechnology. 7 (5): 651-654.

Adeyemo, O.K., 2005. Haematological and histopathological effects of cassava mill effluent in *Clarias gariepinus*. African Journal of Biomedical Research. 8: 179-183.

Agunu, A., Yusuf, S., Andrew, G.O., Zezi, A.U., Abdulrahman, E.M., 2005. Evaluation of fine medicinal plants used in diarrhea treatment in Nigeria. Journal of Ethnopharmacology. 101 (1-3): 27-30.

Ahmed, S., Grainge, M., 1986. Potential of Neem (*Azadirachta indica*) for pest control and rural development. Economic Botany. 40 (2): 201-209.

Ajaiyeoba, E.O., 2002. Phytochemical antibacterial properties of *Parkia biglobosa* and *Parkia bicolor* leaf extracts. African Journal of Biomedical Research. 5 (3): 125-129.

Akinbulumo, M.O., Fagbenro, O.A., Fasakin, E.A., 2008. Acute toxicity of ethanolic extract of *Derris elliptica* roots to *Oreochromis niloticus* fingerlings. Available from: URL: <http://www.ag-arizona.edu/azaqua/ista/ista6web/pdf/223.pdf>. Retrieved: 13-12-08. 11.06 AM.

APHA (American Public Health Association), AWWA (American Water Works Association) and WPCF (Water Pollution Control Federation) (1985). Standard methods for examination of water and wastewater, 15th Ed., American Public Health Association. Washington D. C., USA. p. 1193.

Ayoola, S.O., 2008a. Toxicity of glyphosate herbicide on Nile tilapia (*Oreochromis niloticus*) juvenile. African Journal of Agricultural Research. 3 (12): 825-834.

Ayoola, S.O., 2008b. Histopathological effects of glyphosate on juvenile African catfish (*Clarias gariepinus*). American-Eurasian Journal of Agricultural & Environmental Science. 4 (3): 362-367.

Ayotunde, E., Ofem, B.O., 2008. Acute and chronic toxicity of pawpaw (*Carica papaya*) seed powder to adult Nile tilapia (*Oreochromis niloticus* Linna 1757). African Journal of Biotechnology. 7 (3): 22675-2274.

Ayotunde, E.O., Fagbenro, O.A., Adebayo, O.T., Amoo, I., 2008. Toxicity of aqueous extracts of drumstick, *Moringa oleifera*, seeds to Nile tilapia, *Oreochromis niloticus* fingerlings and adults. Available from: URL: <http://www.ag.arizona.edu/azaqua/ista/ista6web/pdf/200.pdf>. Retrieved: 19-10-08. 10.49AM

- Bardach, J.E., Ryther, J.H., McLarney, W.O., 1972. Aquaculture: The farming and husbandry of freshwater and marine organisms. John Wiley and Sons, Inc., USA, p. 868.
- Bentley, A.O., (1977). Textbook of pharmaceuticals. 8th Ed. Baillière Tindall, London, pp. 177-180.
- Besch, W.K., 1975. A biological monitoring system employing rheotaxis of fish. In: Proceedings of Symposium on Biological Monitoring of water Quality and Wastewater Quality, Blacksbury, USA.
- Cagauan, A.G., Galaites, M.C., Fajardo, L.J., 2004. Evaluation of botanical piscicides on Nile Tilapia (*Oreochromis niloticus* L.) and mosquito fish (*Gambusia affinis* Baird and Girard). Sixth International Symposium on Tilapia in Aquaculture, Manila, Philippines. Sept. 12 – 16. pp. 179-187.
- Chiayvareesajja, S., Chiayvareesajja, J., Rittibhonbhun, N., Wiriyachtra, P., 1997. The toxicity of five Thai plants to aquatic organisms. Asian Fisheries Science. 9: 261-267.
- Dahiya, S., A. Kaur and N. Jain, 2000. Studies on diflouridation of water with *Eichhornia* plant. Journal of Environmental Biology. 21 (40): 337-340.
- Dalziel, J.M., 1955. The useful plants of West tropical Africa, 2nd Ed., Watmoughs Ltd. Idle. Bradford and London, pp. 217-220.
- Das, B.K., Mukherjee, S.C., 2000. A histopathological study of carp (*Labeo rohita*) exposed to hexachlorocyclohexane. Veterinarski Arhiv. 70 (4): 169-180.
- Dede, E.B., Kaglo, H.D., 2001. Aqua-toxicological effects of water soluble fractions (WSF) of diesel fuel on *O. niloticus* fingerlings. Journal of Applied Science and Environmental Management. 5 (1): 93-96.
- EIFAC (1983). European Inland Fisheries Advisory Commission revised report on fish toxicity testing procedures. EIFAC Technical paper No. 24, Revision 1. FAO, Rome, p. 37.
- El-Mahmood, A.M., Ameh, J.M., 2007. *In Vitro* antibacterial activity of *Parkia biglobosa* (Jacq.) root bark extract against some microorganisms associated with urinary tract infections. African Journal of Biotechnology. 6 (11): 1272-1275
- Fafioye, O.O., Jeje, C. Y. (2000). Toxicity of the herbicides Primextra and Gramoxone on two tilipine fish. Biosciences Research Communication. 12: 407-413.
- Fafioye, O.O., Adebisi, A.A., Fagade, S.O., 2004. Toxicity of *Parkia biglobosa* and *Raphia vinifera* extracts on *Clarias gariepinus* juveniles. African Journal of Biotechnology. 3 (11): 627-630.
- Fagbenro, O.A., 1992. The dietary habits of clarid catfish *Heterobranchus bidorsalis* (Geoffery st. Hilaria 1809) in Owerri, Southern Nigeria. Tropical Zoology. 5: 11-17.
- Finney, D.J., 1971. *Probit analysis*. Cambridge University Press. London. pp. 123-125.
- Francis, G., Makkar, H.P.S., Becker, K., 2001. Antinutritional factor present in plant derived alternate fish feed ingredients and their effects in fish. Aquaculture. 199: 197-227.
- Gabriel, U.U., Ezeri, G. N. O., Amakiri, E.U., 2007. Liver and kidney histopathology: Biomarkers of No. 1 fuel toxicosis in African catfish, *Clarias gariepinus*. Journal of Animal and Veterinary Advances. 6 (3): 379-384.
- Ghani, A., 1990. Introduction to pharmacognosy. 1st Ed., Ahmadu Bello University Press Ltd., Zaria, Nigeria, p. 198.
- Horsefall, M., Spiff, A., 1998. Principles of environmental chemistry. Metropolis Ltd, Port Harcourt, p. 112-119.
- Irvine, F.R., 1961. Woody plants of Ghana with special references to their trees. Oxford University Press, London, p. 868.
- Jhingran, V.G., 1983. Fish and fisheries in India. 2nd Ed., Hindustan Publishing Corporation. New Delhi, India.
- Jothivel, N., Paul, V. I. (2008). Evaluation of the acute toxicity of the seeds of *Anamirta cocculus* (Linn.) and its piscicidal effect on three species of freshwater fish. The Internet Journal of Toxicology. 5 (1). ISSN: 1559-3916. Available from: URL: <http://www.ispub.com/ostia/index.php?xmlprinter=true&xmlFilePath=journals/ijto/vol5n1/fish.xml>. Retrieved: 01-09-08: 18:44:40 GMT.
- Katina, P.K., 2000. Freshwater aquaculture in India: Status, potential and constraints. National Center for Agriculture Economics and Policy Research. Workshop Proceedings 7. pp. 88-108.
- Kela, S.I., Ogunsusi, R.A., Ogbogu, V., Nwude, N., 1989. Screening of some plants for molluscicidal activity. Revue d'élevage et de médecine Vétérinaire des pays tropicaux. 42: 195-202.
- Lindesjö, E., Thulin, J., 1994. Histopathology of skin and gills of fish in pulp mill effluents. Diseases of Aquatic Organisms. 18: 81-93.

Microsoft Office Excel 2003 - Microsoft® Windows XP Professional. Microsoft Corporation. Redmond WA 98052-6399, Washington D. C., USA. Available from: URL: <http://www.microsoft.com>.

Mohammed, F.A.S., 2008. Bioaccumulation of selected metals and histopathological alterations in tissues of *Oreochromis niloticus* and *Lates niloticus* from lake Nasser, Egypt. *Global Veterinaria*. 2 (4): 205-218.

Obizoba, I.C., 1998. Fermentation of African locust bean. In: Osagie, E. (Ed.). Text on nutritional quality of plant fruits. Post harvest research unit, Department of Biochemistry. University of Benin, Nigeria, pp. 160-198.

Obomanu, F.G., Ogbalu, O.K., Gabriel, U.U., Fekarurhobo, S.G.K., Abadi, S.U., 2007. Piscicidal effects of *Lepidagathis alopecuroides* on Mudskipper, *Periothalmus papillio* from the Niger Delta. *Research Journal of Applied Sciences*. 2 (4): 382-387.

Olufayo, M.O., 2009. Haematological characteristics of *Clarias gariepinus* (Burchell, 1822) juveniles exposed to *Derris elliptica* root powder. *African Journal of Food, Agriculture, Nutrition and Development*. AJFAND ONLINE. 9 (3). ISSN: 1684-5374. Available from: URL: <http://www.ajol.info/index.php/ajfand/article/viewFile/43115/26663>. Accessed: 21-08-09. 6.42PM.

Omitoyin, B.O., E.K. Ajani, B.T. Adeshina and C.N.F. Okuagu, 2006. Toxicity of Lindane (Gamma Hexachloro – CycloHexane) to *Clarias gariepinus* (Burchell 1822). *World Journal of Zoology*. 1 (1): 57-63.

Omoniyi, I.A., O. Agbon and S.A. Sodunke, 2002. Effects of lethal and sublethal concentrations of Tobacco (*Nicotiana tabacum*) leaf dust extraction on weight and haematological changes in *Clarias gariepinus* (Burchell). *Journal of Applied Science and Environmental Management*. 6: 37-41.

Sambasiva-Rao, K.R.S., 1999. Pesticide impact on fish metabolism. Discovery Publishing House, New Delhi. India.

Souf, H., Soliman, M., El-Manakhly, E., Gaafa, A., 2007. Some biochemical and pathological investigations on monosex Tilapia following chronic exposure to carbofuran pesticides. *Global Veterinaria*. 1: 45-52.

Svobodová, Z., Llyod, R., Machová, J., Vykusová, B., 1993. Water quality and fish health. EIFAC Technical paper 54, FAO, Rome, p. 59

Terry, G., 1987. Breaking the pesticide habit. Alternative to 12 hazardous pesticides. IASA Publication, p. 317.

Tiwari, S., Singh, A., 2005. Possibility of using latex extracts of *Nerium indicum* plant for control of predatory fish, *Channa punctatus*. *Asian Fisheries Science*. 18: 161-173.

Usman, J.I., Auta, J., Adamu, A.K., Abubakar, M.S., 2005. Toxicity of methanol extract of *Euphorbia laterifolia* (Schum and Thann) to the juveniles of the African catfish (*Clarias gariepinus*) (Teugels). *ChemClass Journal*. 2: 59-61.

Wade, J.W., Omoregie, E. Ezenwaka, I., 2002. Toxicity of cassava (*Manihot esculenta* CRANTS) effluent on the Nile Tilapia, *Oreochromis niloticus* (1) under laboratory conditions. *AJOL. Journal of Aquatic Science*. 17(2): 89-94.